Water-Energy-Food Nexus Governance in India addressing farmers' inclusivity and climate impact

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CWAS CENTER FOR WATER AND SANITATION CRDF CEPT UNIVERSITY

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Need

Fourth successive drought in Bundelkhand (2018)- First Post

Bengal Famine (1943)- The Wire (3 million death)

India blackout (2012)- The Orange County register

Conflicts

Central India after drought- WaterAid

"Water, water, everywhere,
nor any drop to drink"
– Samuel Taylor Coleridge

"The wars of 21st century will be fought over water"
- Ismail Serageldin, Former vice-president of World Bank 1995

THE SCIENCES

Study Says Winston Churchill's Policies Caused the 1943 Bengal Famine

Researchers in India and the US used weather data to prove the now-infamous accusation as the rain levels were above average in 1943.

Cape Town
South Africa

Cauvery Dispute
Karnataka, Tamil Nadu, Kerala

Tehri Dam Project
Uttrakhand to Delhi (330 km)

Shimla
Water crisis

Chennai, Bengaluru, Mumbai, Delhi

China
& its neighbouring countries

Bengal Famine (1943)
3 million death

Nile River Basin

Great Famine (Ireland)
1 million death (1845-52)

India Pakistan Water Issue

Introduction

WORLD IS CHANGING

- Urbanization
- Economic growth
- Technological advancement
- Climate change
- Population growth
- International trade
- Expanding the discourse on security
- Globalisation
- Growing inequalities

?

MAJOR CHALLENGE

To manage demand and supply of resources for sustainable growth

OPTIMIZATION

Minimising risk and maximising human-environment security

Water Energy Food Interaction

This research covers:

Goals
SDG 2: Food
SDG 6: Water
SDG 7: Energy

Effects Directly
SDG 1: Poverty
SDG 3: Health
SDG 8: Economic Growth
SDG 9: Infrastructure
SDG 11: Sustainable Cities
SDG 13: Climate action
SDG 14: Life below water

Effects In-directly
SDG 4, SDG 5,
SDG 10, SDG 12, SDG 15,
SDG 16, SDG 17

Demand by 2030

Water	40%
Energy	50%
Food	35%

Source: USNIC

Interlinkages between Water, Energy, and Food Sectors

Complex & inter-related nature of global resources systems

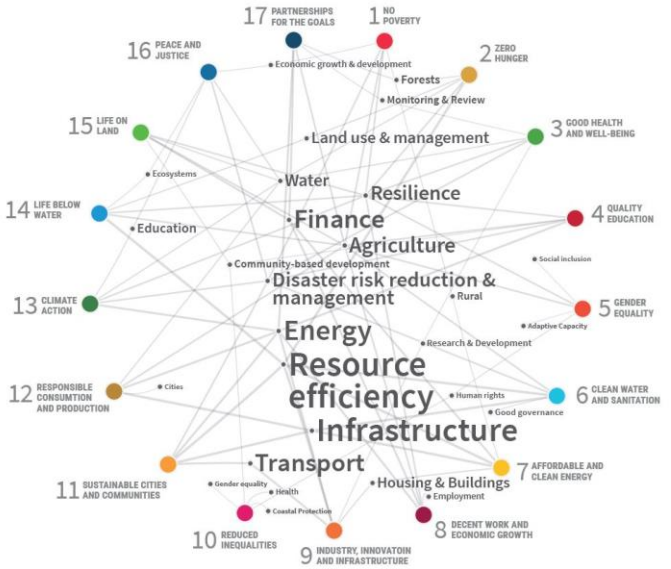
To achieve socio-economic and environmental goals

Trade and investment

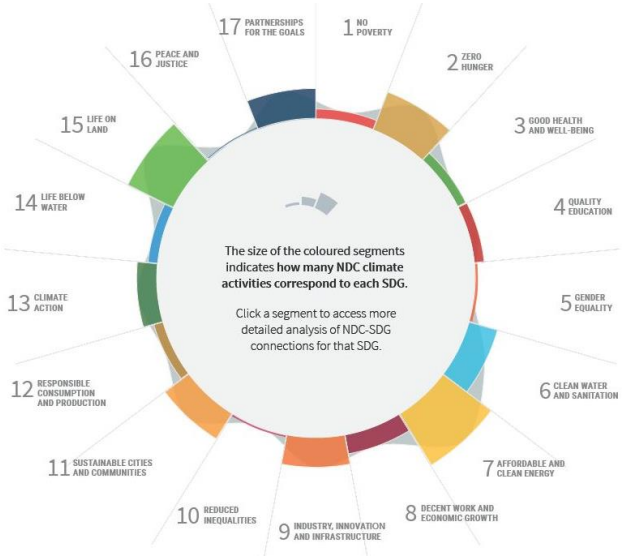
Climate Change

W-E-F Security

Nexus Emergence & SDGs



Socio-economic sectoral categories that appear across numerous SDG-relevant Nationally Determined Contributions (NDC) activities



NDC activities in the 17 SDGs

The literature suggests that nexus approach has **no fixed concept,** but it can be identified as a more **integrated approach for sustainable development** by linking ideas of different sectors and actions of numerous stakeholders.

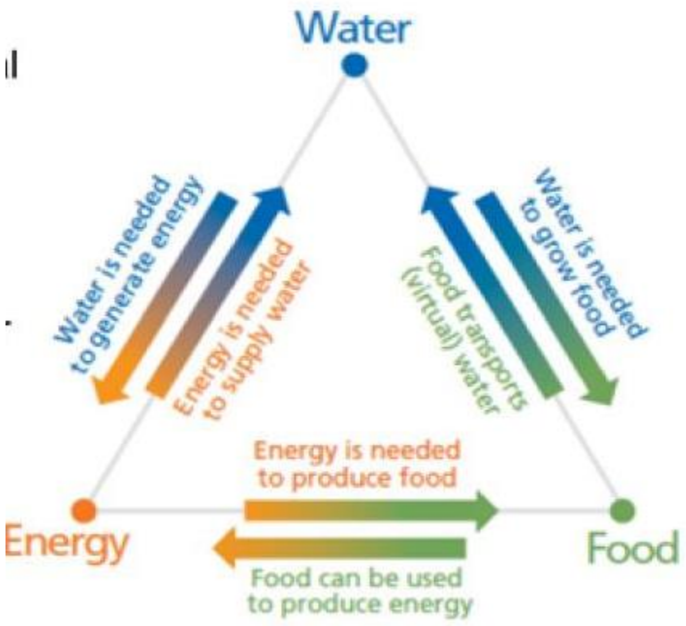
Many Nationally Determined Contributions (161 NDCs) need to be scrutinized regarding their **potential impacts on either water, energy and food security** – and may relate to trade-offs or synergies.

Source: SDG , UNDP; Stockholm Environment Institute , Nexus Logic

WEF Nexus

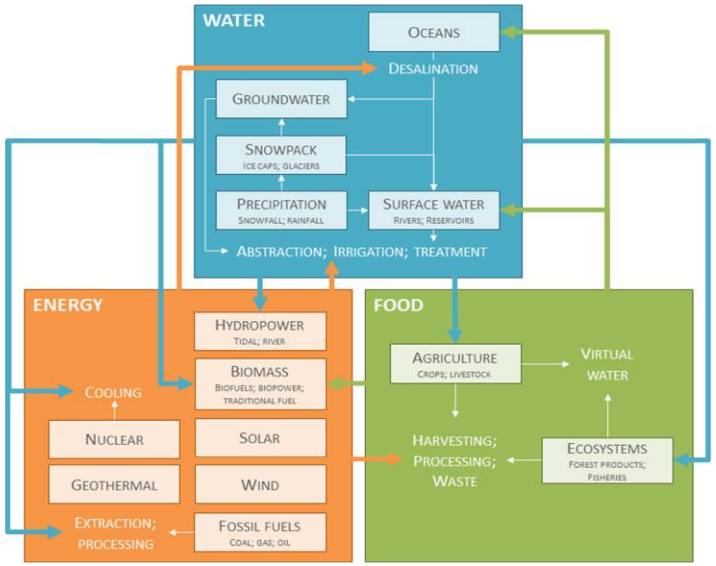
Nexus thinking helps in evolving nexus methods, which are **inventive, innovative, context-based, collaborative and implementable**. Nexus thinking highlights two important initiatives that are “the need to address **conceptual tensions in disciplinary boundary crossing** and how to move from theory to practice in operationalizing nexus goals”(Hayley Leck, 2015).

Nexus thinking is a **system-based approach** that recognizes **interconnectedness and interdependency** of water-energy-food system (Dale Keairns, 2016).



Interactions between Water-Energy-Food

Source: By IBM 2009, UNU 2013



The environmental nexus system defines the major flows within and between water, energy and food systems

Source: By Biggs, 2015

Definitions

Authors and organisations

Bonn 2011,
Hoff 2011,
World Economic Forum (2011),
Mattor 2013,
Ringler 2013,
Rees 2013,
UNFAO 2014,
Mohtar 2014,
Reynolds 2014,
Stirling 2014,
Biggs 2015,
Leck 2015,
Dale Keairns, 2016,
Royal Geographic Society 2016,
Jackson 2016,
T R Albrecht 2018, etc.

Methodology

Qualitative & Quantitative data collection

Identification of gaps, issues, and challenges

Literature review

Title

Aim & Objectives

Theory, Hypothesis & concept

Data Collection

Secondary Source

Literature Review

Case Studies

Govt. Records

Primary Source

Primary HH Survey

Observations

Delphi Technique

Application of Statistical Technique

Data Analysis

Modelling

Model Validation

Forecasting

Forecasted year Model

Application of Model

Results & Deduction

Findings

Evolving policies

Recommendations & Conclusion

Reliable & Accurate

- ❑Reputed global organization
- ❑Government reports
- ❑Peer-reviewed journal
- ❑Indexed Journal
- ❑Recent data (2003-2019)
- ❑Reports
- ❑Data from Global, National , & Local level

- •Census
- •Seminars
- •Workshops
- •Conferences
- •Programs
- •Research work
- •Archives
- •WEF official websites
- •Official government websites

- Explored plausible futures based on strategies and scenario analysis
- WEF Nexus specific recommendations given

Reconnaissance survey **(On-site)**

Meeting with Primary Stakeholders

Formation of Schedule

Expert Advise using Delphi Technique

Door to door survey (550 survey in 8 blocks & one municipality) **(On-site)**

Finalizing the Schedule (cross-section descriptive schedule)

Pilot Survey **(On-site)**

Modification in Schedule

Data Filling in excel sheet

Tabulation & graph formation

Data Analysis: Application of **Statistical techniques** like correlation and multiple regression

Identification of control parameters

Conceptual models (CLD)

Identifying key variables

Identifying linear & non-linear relationships

Considering dynamic behavior (spread & backwash effect)

Conceptualizing Mental Model

Model Formulation

- Stocks, flow, & feedbacks
- Setting model boundaries
- Formulating mathematical equations for each relationship
- Providing parameters with numerical value

Model Simulation

Model Validation

Model Reformation

Application of Model

Water Sector- Five-Year Plan Analysis

National water policy and sanitation programme: To assist the States in the implementation of their urban and rural water supply and sanitation schemes e.g.- well construction and refurbishment

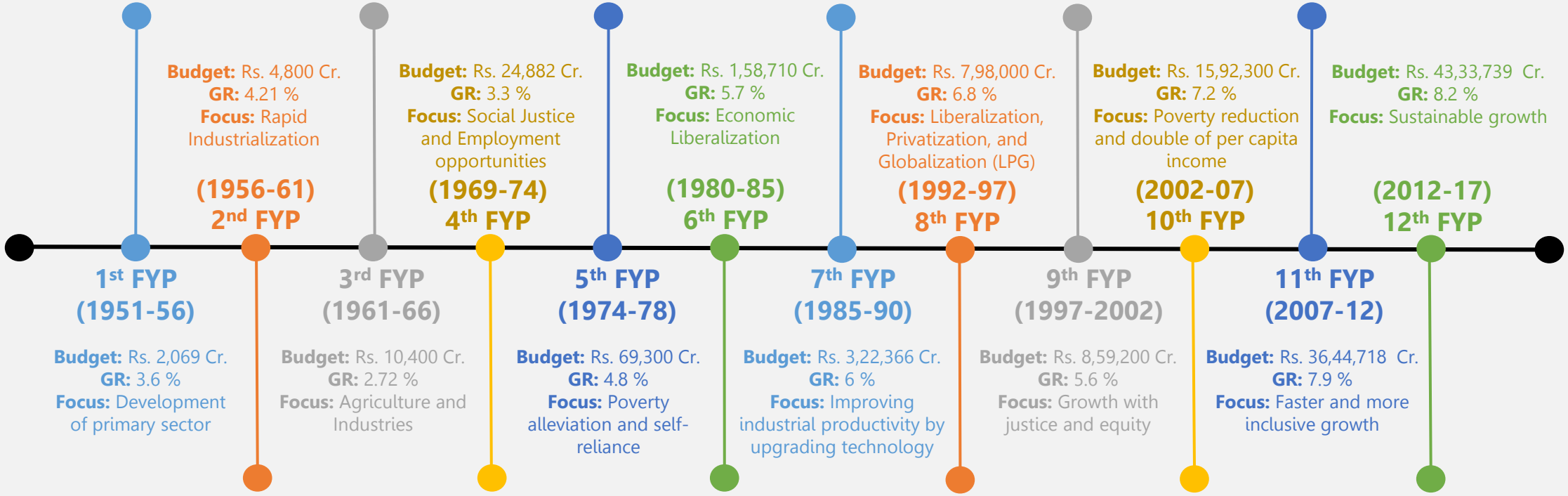
Effective coordination between all agencies: At the district and block level and to mobilize local initiative and contribution to the utmost. Rs. 67 Cr for rural water supply.

Potable water and sewerage: a) Potable drinking water in villages, b) strengthen piped water supply in urban areas, c) fully covered sewerage facilities in industrial cities

National Water Policy: Drafted by the Ministry of Water Resources in 1987

Revised policy for rural areas: The implementation of the rural water supply approved by the Union Cabinet

Bharat Nirman Programme: Envisages the creation of 10 m. ha. additional assured irrigation during the four years period



Rural water supply scheme: For community development, local development, works, and welfare of backward classes. Supply to groups of villages.

National water supply and sanitation programme: Implemented by the Ministry of Health in water-scarce regions with salinity issues and where water-borne diseases were endemic.

Minimum Needs Programme: Only 10% rural area was covered, so more provision of an outlay was provided to MNP

Safe drinking water and conservation: a) water quality monitoring, b) replacement and rejuvenation, c) conservation of water and recharge of aquifers on a large scale

Safe and sustainable water: To provide safe and sustainable drinking water to rural habitations

Domestic water and sanitation: A Steering Committee was to formulate Domestic Water and Sanitation (Urban and Rural).

Energy Sector- Five-Year Plan Analysis

Electric power and irrigation: Rs. 558 Cr was allocated for irrigation and electric power development. Almost 1 MkW power was expected to 16.9 million acres (518 million), and the remaining 40 Cr was dedicated to starting five projects for electric power development in the last two years

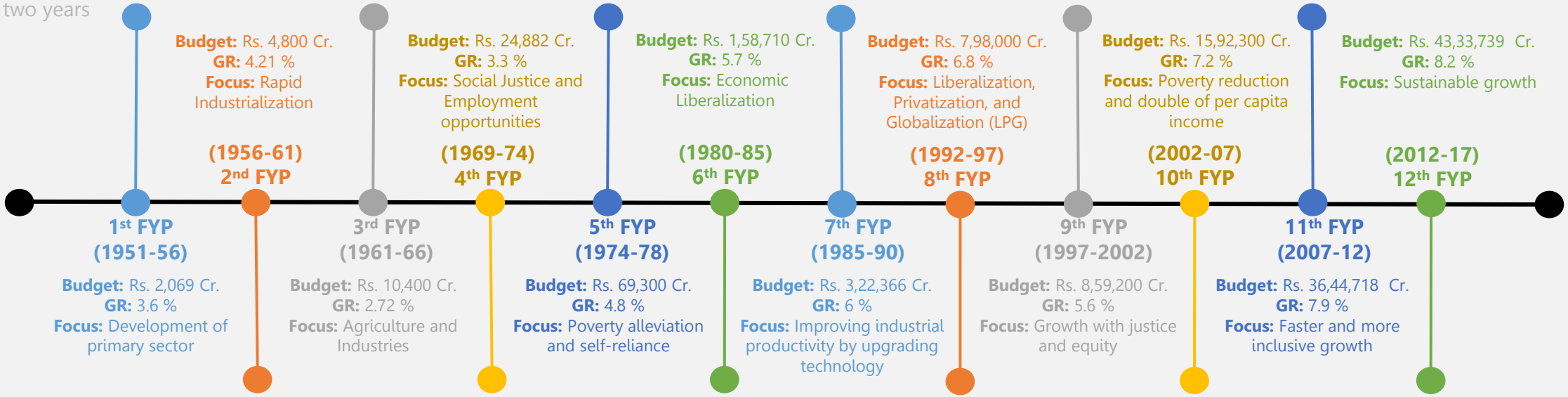
Research on Hydropower: Budget- Rs. 1089 Cr. Generating capacity = 5.7 MkW. Required total installed capacity increased to 12.7 MkW. Seven research on hydropower generation, transmission & distribution.

Electricity Supply Act 1975: Rs. 7399.50 Cr was dedicated to the power sector. The central government entered through Electricity Supply Act 1975. NTPC, NHEPC & NEEP were set up to coordinate & formulate policy. Super thermal power plant proposed.

Various sources of generation: Total generating capacity- 42.58 MkW: Gas based- 0.72 MkW, Nuclear- 1.09 MkW, Thermal- 23.61 MkW. Proposed- 22.24MkW

Decentralization and maximum efficiency: Capacity- 104.92 MkW, Budget- 1,15,870 Cr. Emphasis on facilities, generating efficiency, end-use, and loss reduction. Decentralization was proposed.

Policy on reducing carbon emission: Budget- Rs. 5,72,648 Cr. It outlines Integrated Energy policy and focuses on reducing carbon emission & economizing costs. Energy pricing and policies for major energy-producing sectors were considered necessary. It envisaged increasing primary energy availability.



New Generation Capacity: Rs. 427 Cr was dedicated to yield 3.5 MkW. New generation capacity included hydropower, thermal (significant), and diesel (small amount). Power load surveys were undertaken for future planning due to the increasing rate of change in demand.

Atomic & Thermal projects (Grid System): Required generation capacity to 23.6 MkW (Rs. 2447.57 Cr). Investment on atomic, thermal & hydroelectric projects. Power shortage & excessive transmission losses were encountered. All India grid systems were proposed.

Installation by NTPC: Rs. 19, 265 Cr for power sector with capacity 48.16 MkW. Installation done by NTPC. Issues were transmission, distribution, and load factor. Priority- Hydel Project.

Power Supply Reliability: Proposed- 30.538 MkW. Budget allocated- Rs. 79,589 Cr (62% share for transmission and distribution). Emphasis on power supply reliability to consumers.

Majority outlay share dedicated to electric power: The outlay on power is Rs. 2, 72, 076 Cr which is 18.2 % of total outlays and expenditure was Rs.1, 82, 380.02 Cr, which is 14.5% of total expenditure.

Sustain energy demand and renewable energy: Budget- Rs. 4,48,736 Cr. Adding 88 MkW to existing. To sustain energy demand & energy efficiency, maintain affordable prices, and keep energy import at a reasonable rate. Increased involvement of private sector; includes policy related to efficiency, pricing, and technology—expansion of renewable energy.

Agriculture Sector- Five-Year Plan Analysis

Focus on the primary sector: Distribution in irrigation & energy (27.2%), agriculture & community (17.4%), and rehabilitation of landless farmers (4.1%)

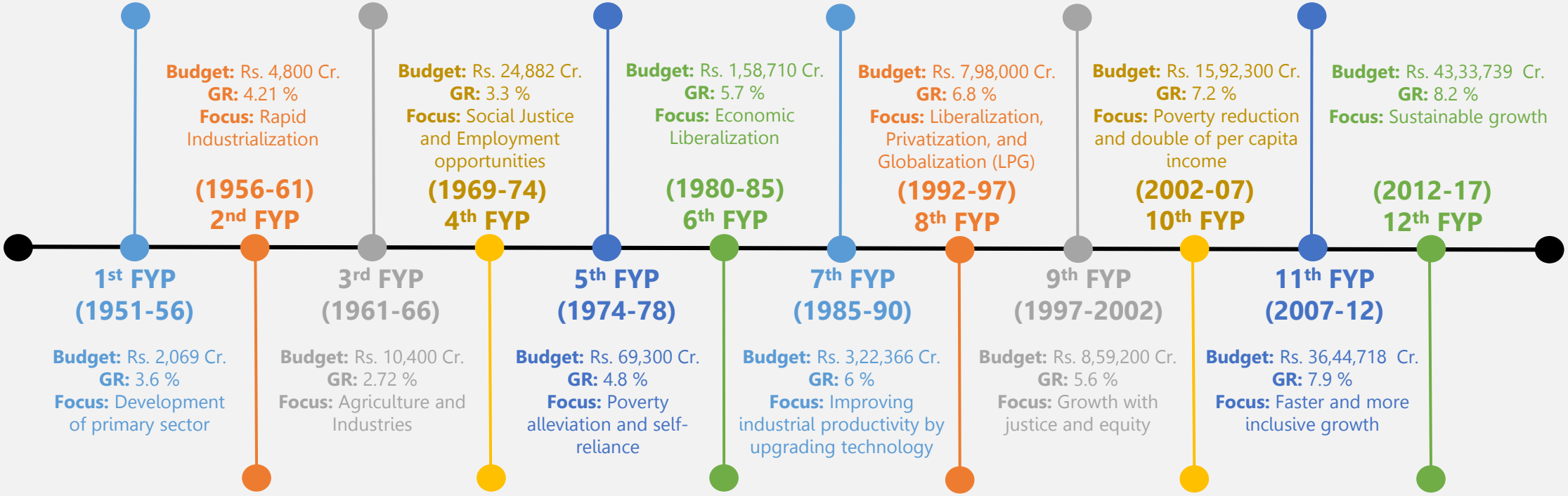
Agriculture Production: Focused on the improvement of agriculture and production, but war with China and Pakistan shifted towards defense

Self-Reliance: Self-reliance in defence and agriculture production was the main agenda of this plan. Poverty removal and employment were also highlights of this program.

Food, work, and productivity: To improve food grain production, modernization, technological advancement, and social justice were key criteria

Basic Minimum Services: BMS and social sector were prioritized. Special Action Plans (SAPs) were evolved to achieve the targets.

Inclusive growth and employment: Higher education, gender equality, and environmental sustainability were considered. An increase in agriculture output by 4% was targeted.



Industrial Development: Main focus was industrial development

Growth with stability: Major breakthrough in the field of advanced agriculture, causing Green Revolution. This plan faced a major setback due to the Indo-Pak war.

Infrastructural development of rural areas: Food price increase due to the removal of ration shops and price control. NABARD was established to promote agriculture and IRDP to eradicate rural poverty.

Prioritizing the energy sector: HRD like education, health, employment, etc., were targeted. The private sector got priority over the public sector. Planning Commission reconstituted

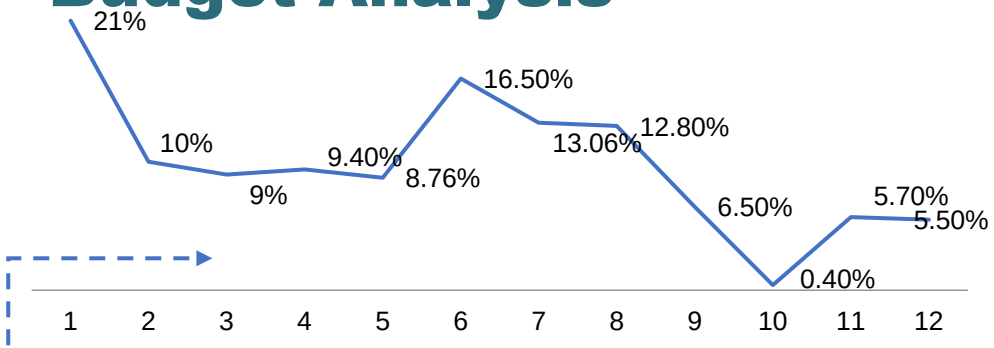
Improved quality of life: TGDP growth, poverty reduction, and double per capita income were the objectives. The social sector, PRI involvement, development, and agriculture were also factors that were considered.

Holistic development: A Holistic water management policy, focus on the agricultural sector, ensuring electricity in all villages, infrastructure development, and a growth rate of 9% were the main targets.

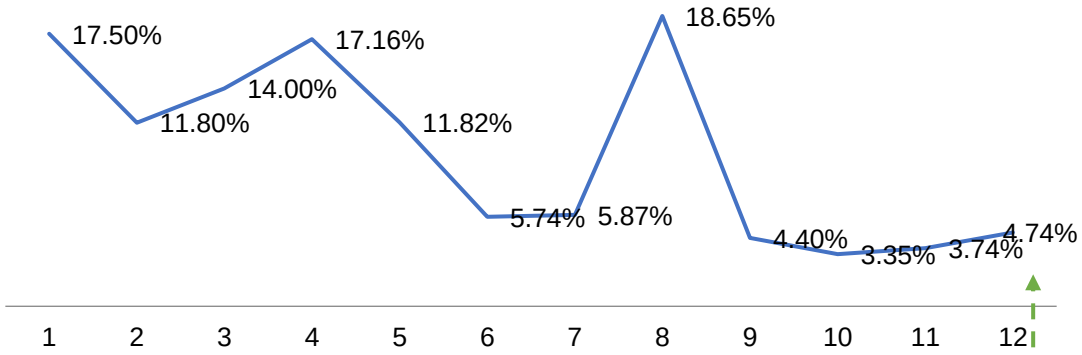
Budget Analysis

Source: Planning Commission, NITI Aayog

Five-Year Plans



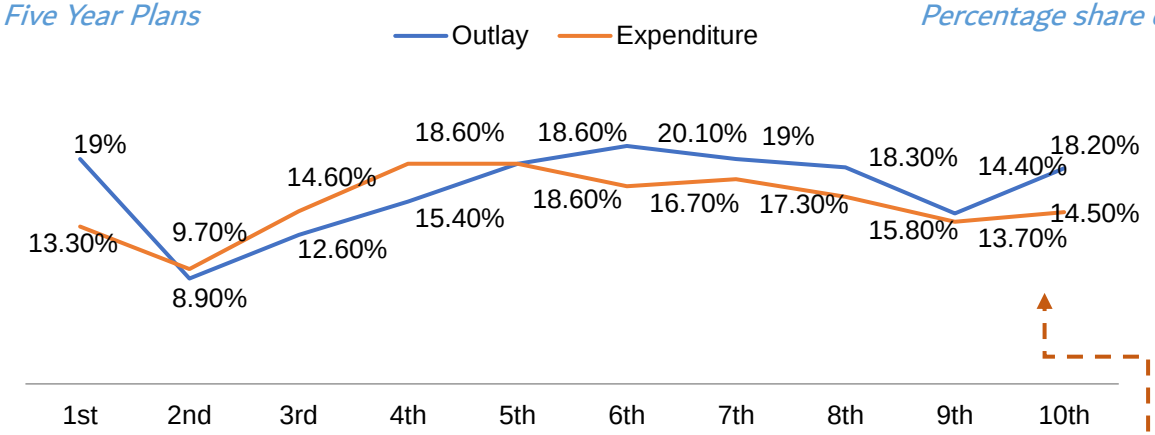
Percentage share of Outlay of Water Sector in Five Year Plans



Percentage share of Outlay of Agriculture Sector in Five Year Plans

"The Indian economy and society face daunting challenges in the water sector."- *NITI Aayog*

India is one of the major drought-prone countries due to the decreasing availability of per capita water and increasing population



Percentage share of Outlay of Energy Sector in Five Year Plans

Even till 2019, 58 per cent of India's population depends on agriculture as primary source of livelihood, but the **investment** trend in agriculture sector is uneven **declining** and so is the contribution of agriculture sector to **GDP (1951-52%, 2019-15.96%).** *(Plecher, 2020)(Planning Commission).*

Water Sector

- *Resource management*
- *Mismanagement and lack of transparency*
- *Illegal activities and corruption*
- *Failure of public water supply*
- *Lack of community ownership*
- *Inadequate information*
- *Water pollution & Env. issues*

Food Sector

- *Decline in GDP contribution*
- *Low productivity & indebtedness*
- *Skewed land distribution*
- *1/4th of the world's hungry population & 190 million undernourished*
- *Inadequate labour force*
- *Agriculture practices*
- *Socio-economic schisms*

Energy Sector

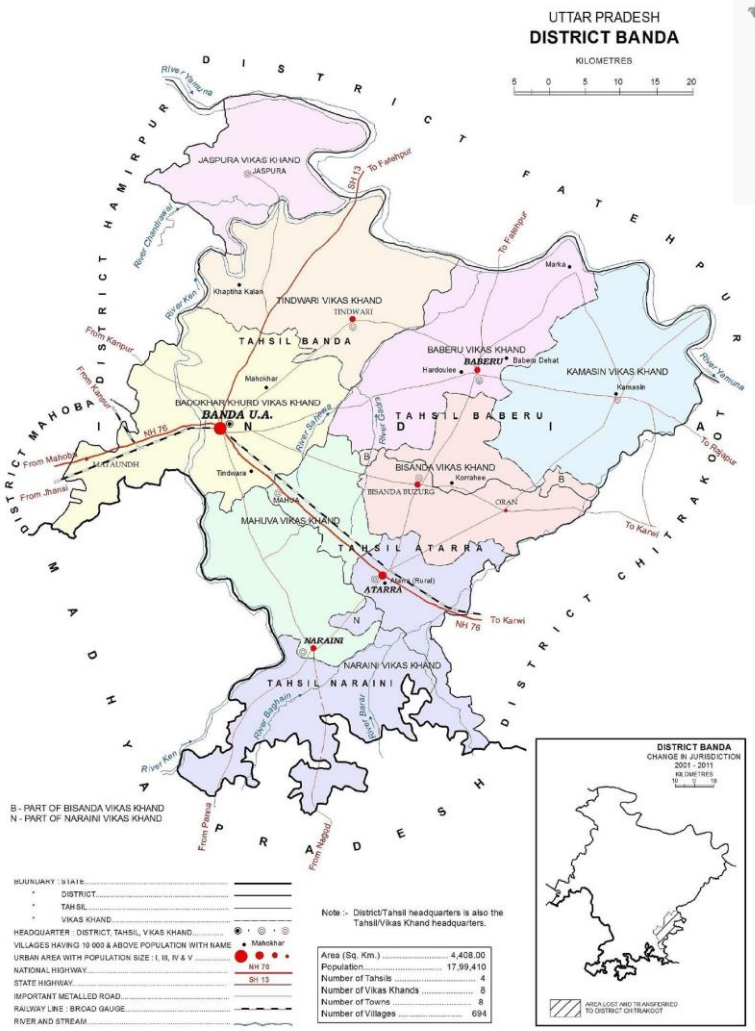
- *Demand and supply imbalance*
- *High fossil fuel dependency*
- *Inadequate env & social issues abatement*
- *Lack of clean energy and dependency on biomass*
- *Weak coordination*
- *Unforeseen climate impacts*
- *Blurred implementation policies*

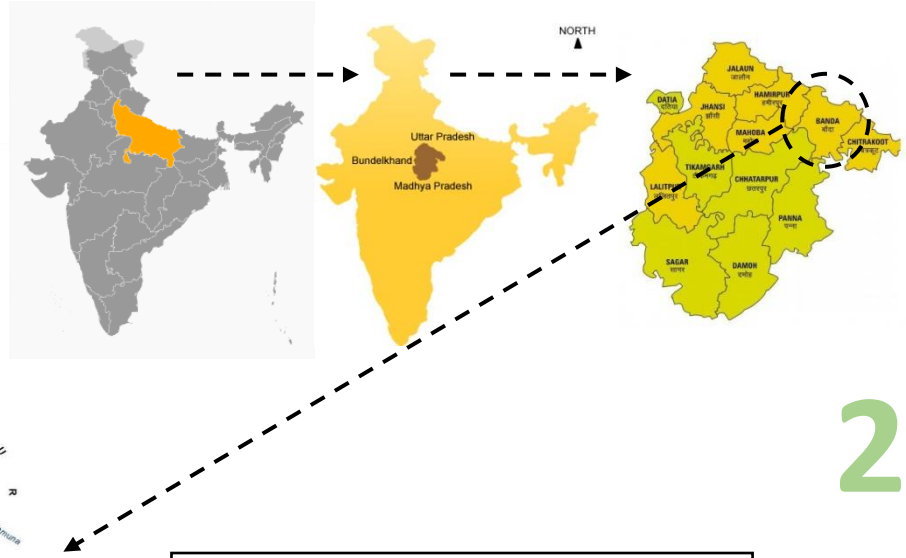
"Electricity Getting"- Ease of doing business, India's rank has been shifted from 137 in 2014 to 22 in 2019 *(IBEF, 2020).*

In 2018, India was ranked 5th in renewable energy installed capacity, 5th in solar power and 4th in wind power. *(MNRE, 2018).*

Gaps & challenges

Study Area





- Uttar Pradesh becomes **8th state to declare drought,**
- **Out of 75 districts, 50** are drought hit (as the state department report).
- Most backward and drought hit **Bundelkhand region** is chosen for the present investigation.
- Bundelkhand region is divided into two parts UP and MP and comprises of 13 districts. **UP- 7 districts & MP- 6 Districts**

Banda, U.P.

4408 Sq. km. Area of Banda District, UP

20.4 Crores Population of UP (2012)

15.3% Urban Population

1.83 Crores Population of Bundelkhand, 52.5% in UP

4 Tehsils
8 CDBs, **8** Urban Centers
694 Villages
3 rivers Ken, Betwa, Yamuna

17.9 Lakhs Population of Banda District, UP

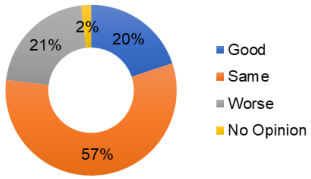
408 Person per sq. km. Density on Banda

Bundelkhand covers **12.21%** area of Uttar Pradesh, but shares only **4.84%** of population?

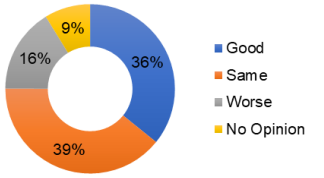
↑ **67%** Literacy
↓ **17%** Population Growth
↓ **16%** Child Proportion
← **863** Sex ratio

Study Area

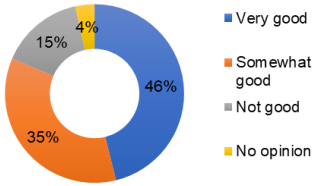
Banda, U.P.



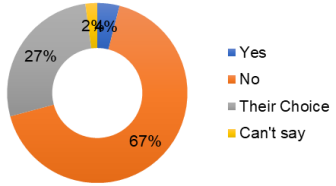
Economic conditions compared to five years ago



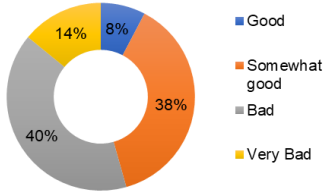
Economic condition of farmers in next five year



How is city life compared to rural life?

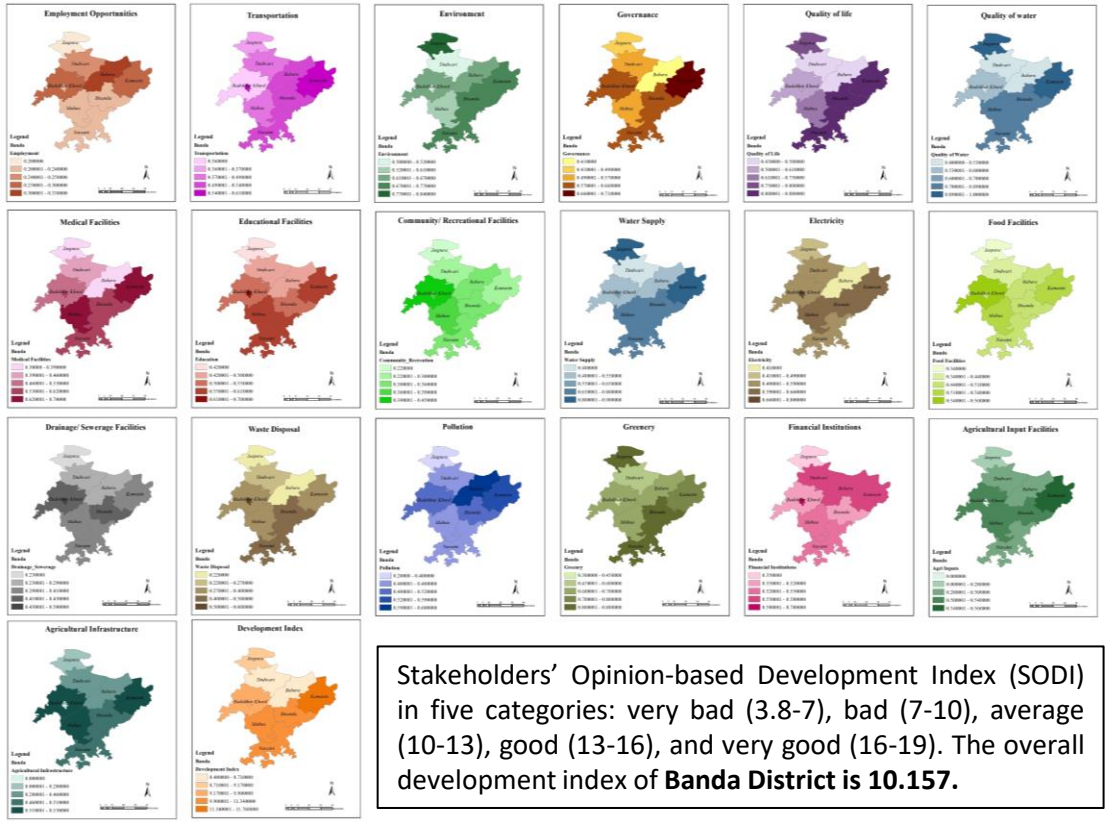


Would you like your children to do farming?



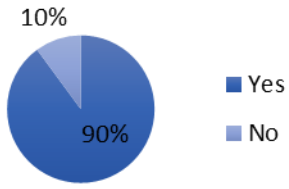
Overall condition of farmers in India

- **Water Consumption:** < 40LPCD- 51%, 40-135 LPCD- 42%, >135 LPCD- 7%
- **Electric Energy Availability:** Government- 77%, No Electricity- 21%, Govt + Solar- 1.69%
- 60%- **Marginal Farmers**, 23% - **Small Farmers**
- **52%** farmers think that they don't get fair price of produce
- **64%** employed only in agriculture, while others have other employment as well
- Farming opinion: **Like- 55%, Dislike- 42%**

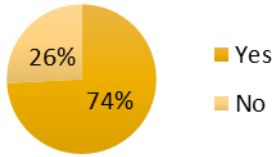


Stakeholders' Opinion-based Development Index (SODI) in five categories: very bad (3.8-7), bad (7-10), average (10-13), good (13-16), and very good (16-19). The overall development index of **Banda District is 10.157.**

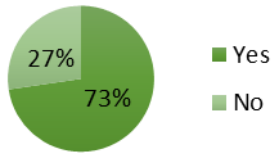
Water Scarcity



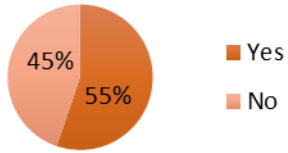
Energy Scarcity



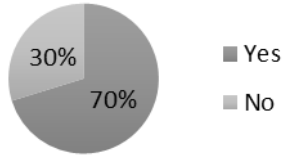
Food Scarcity



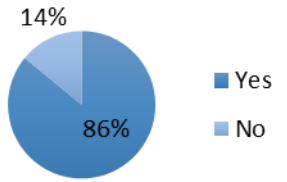
WEF Knowledge



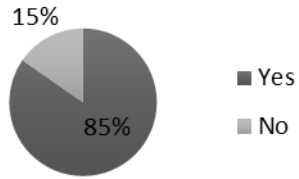
WEF Impact



WEF Awareness

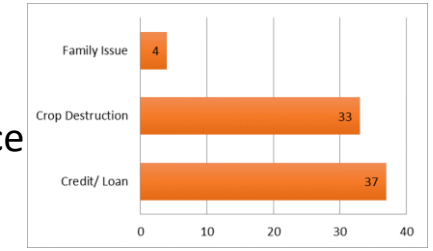


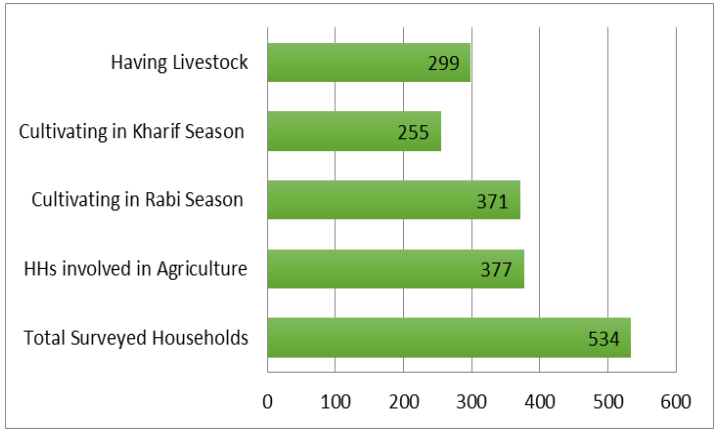
WEF Improve Society



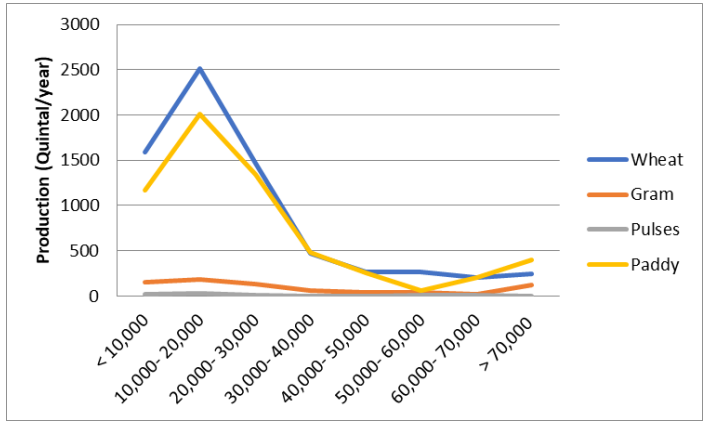
Agriculture

- **72%** farmers sell their produce
- **52%** farmers think that they don't get fair price of produce
- **Selling:** Open Market- 66%, APMC- 29%, Middleman- 5%
- **Seeds used**: **Local- 62%, Hybrid- 35%, Both- 3%**
- **74%** farmers are not satisfied from government irrigation scheme
- **79%** farmers said there were no government scheme in last 15 years
- **98%** farmers faced crop destruction in last 3 years

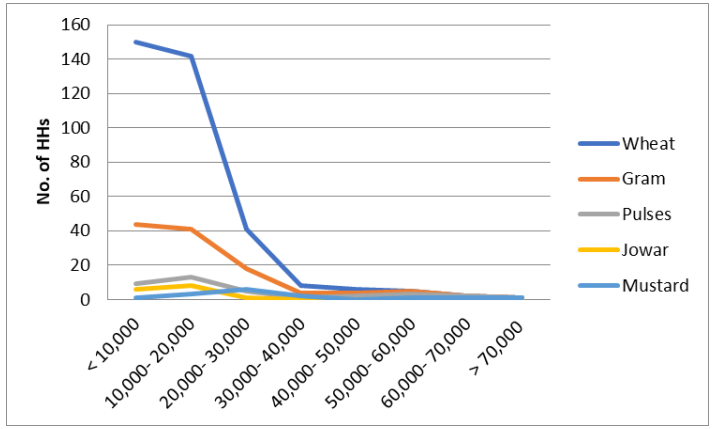




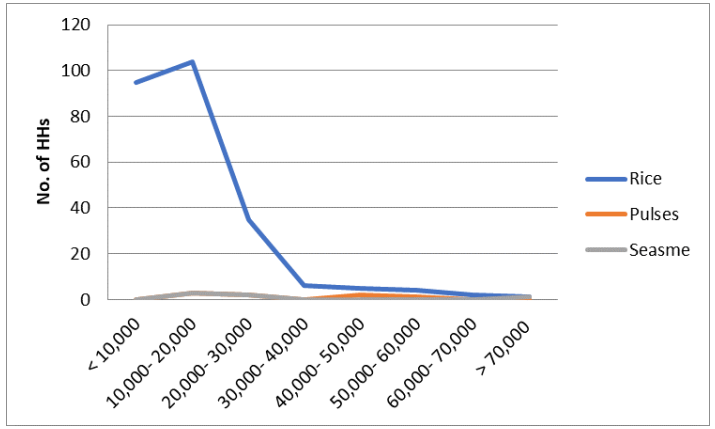
Cropping Pattern and livestock in total households



Total quantity of crops production

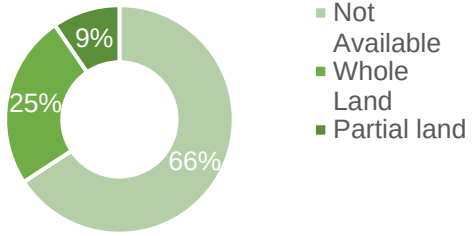


Rabi Crops

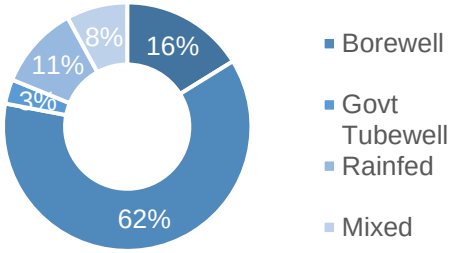


Kharif Crops

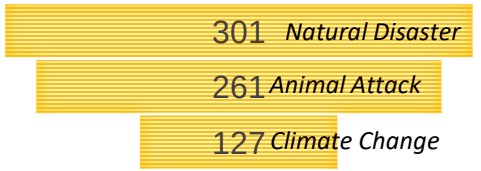
Irrigation Availability



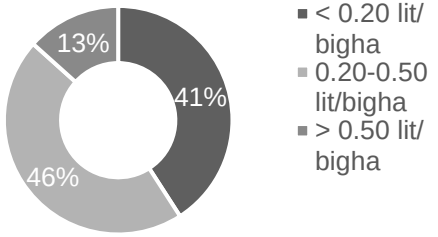
Irrigation



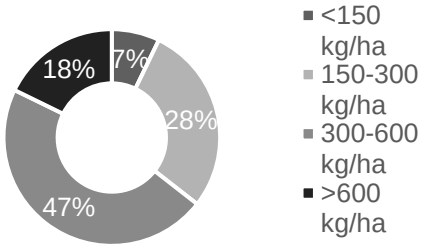
CROP DESTRUCTION



Pesticide Use



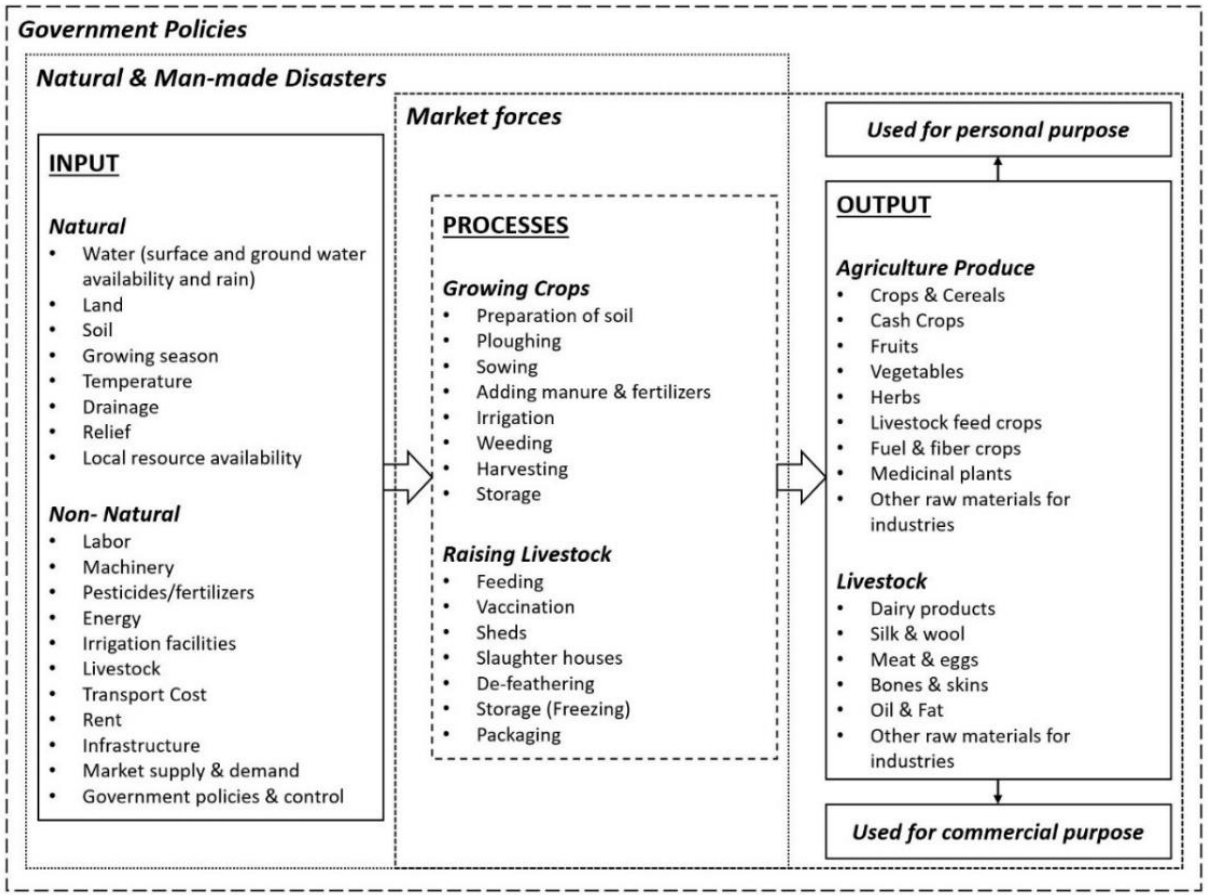
Fertilizer Use



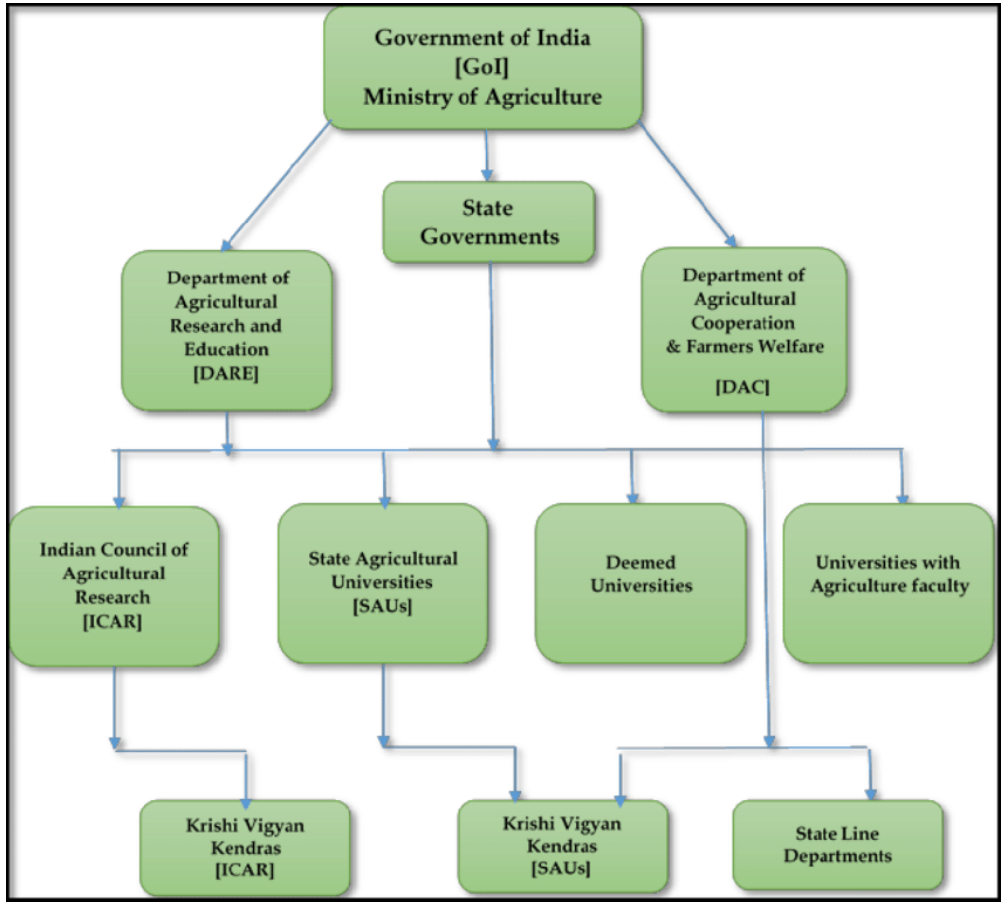
- **65.5%** farmers use **pesticides**
- **96.5%** farmers use **chemical fertilisers**
- **14%** farmers know of **suicide** in the village
- **73%** farmers says **government is responsible** for poor condition of farmers
- Biggest problem of farmers are- **animal attack, water scarcity, policy issues, lack of infrastructure, and natural disaster/ climate change.**

Primary Data analysis

Results



Food System Layout- *Source: By authors*

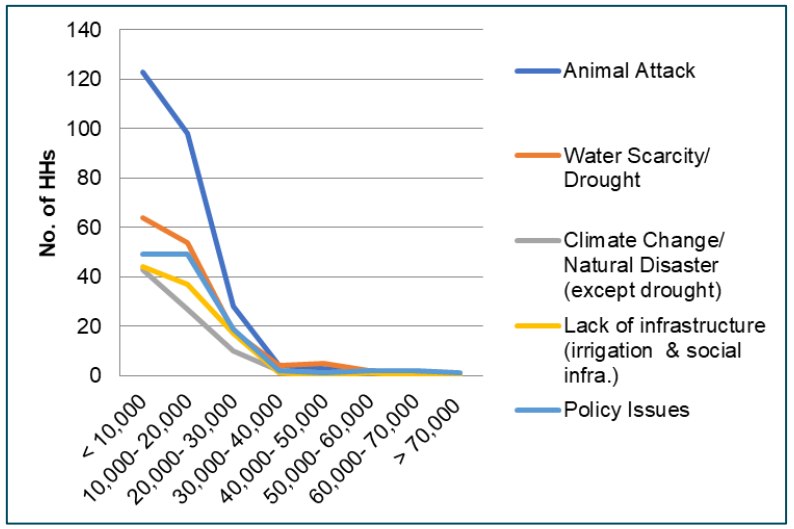


Agriculture Institutional Hierarchy- *Source:* (Sastry & Kumar, 2017)

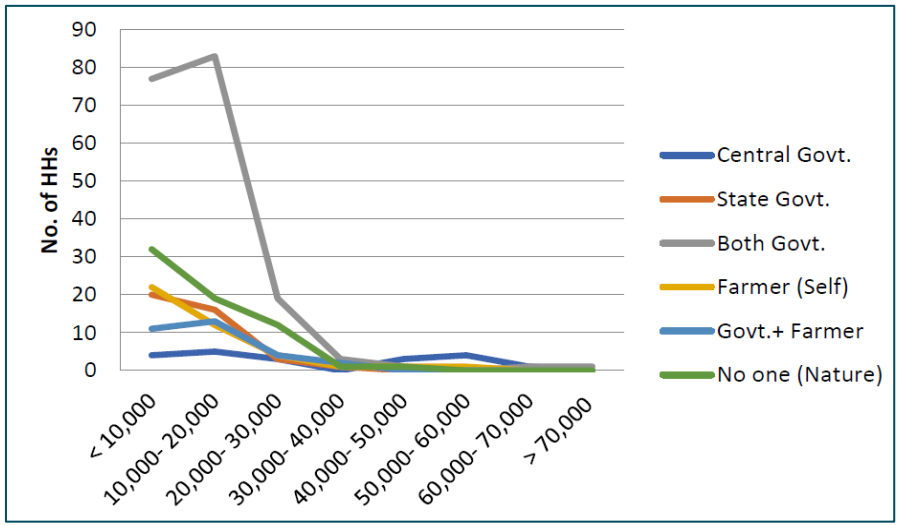
The ***public institutions*** have a definite and conscious role to play in the contribution for ***the agricultural growth and development*** in India. They have been structured at different levels to address the needs of the ***farmers and agri-preneurs*** (An agricultural entrepreneur) of the country.

Figure depicts the flow of ***technology solutions*** through agricultural ***R&D*** to reach the ***stakeholders*** of the agrarian system

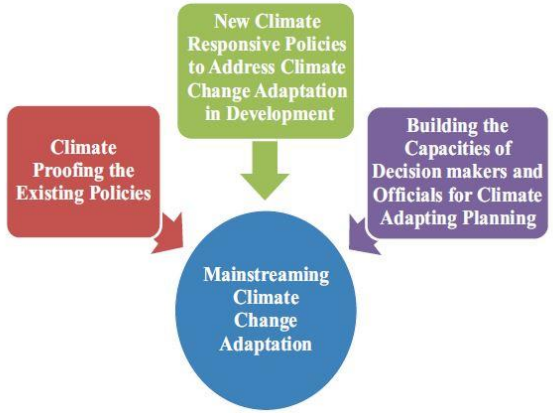
Results



Challenges of farmers



Who is responsible for the farmer's poor condition?



Mainstreaming Climate Change Adaptation in the planning process- *Source:* (Bisht, 2014)

- **Biggest challenges are:**
  - Animal Attack (68.44%)
  - Water scarcity/drought (38.99%)
  - Policy issues (33.16%)
  - Lack of infrastructure (26.25%)
  - Climate change & natural Disaster (22.55%)
- **Policy issues** involve no platform for farmer grievances, improper market rates, seed & fertilizer rates and distribution, improper government schemes like housing, and market & management issues, inflation, etc., and untimely aid.

- Almost **three fourth (72.95 %)** of the households involved in agriculture believe that the **government**, both central or state, is **responsible for the poor condition** of the farmer.
- Other reasons:
  - Farmer himself (10.88%)
  - Natural reasons (16018%)
- Majority of the farmers believe that the **negligence of the government and faulty policies** are responsible for farmers' poor condition.

- Some ways to achieve Adaptation process:
  - **Linkages** between line departments
  - **Cost-benefit analysis**
  - **Awareness** of adaptive policies to decision-makers
  - Short, medium, long term **planning to minimize losses**
  - Policy realignment and **synergies identification** for vulnerable communities
  - **Climate Smart vision**
  - **Structured and systematic approach** to implementation and monitoring

Recommendations

Sustainable development of the **primary sector** to **benefit local economies** by **generating jobs and income** for a better **lifestyle**; to **stop out-migration.**

Policy

Policy Coherence between Central, state, and district governance system across WEF Sector

Development plan: Objective and flexible to adopt alteration, to be implemented with precision, and discussed with stakeholders.

Credit system: Upgradation by banks to ease of use and loan recovery.

Relief measures: Short-term assistance for borewell, RWH, and other construction. (District level)

Awareness

Awareness: Water harvesting, traditional methods, conservation, & SDGs

Awareness: Training and hands-on for technical knowledge, new methods, integrated development, citizen participation, & decision making

Community-based Disaster Management: Rainfall, drought, O&M, GW recharge, small reservoirs, watershed, etc

Supply-Chain

Improving Supply chain: Regulating middlemen, collection unit (mandis) at village level, Min. price for agri products. To safeguard interest of small and Medium Farmers from middlemen

Farm Design

Periodic proportionate farming: 30% Forest & Orchards, 30% Livestock & fodder, 30% Self-sustenance, 10% to be dedicated to water harvesting, processing & societal benefit (co-existence).

Innovation

Agri Machinery: Improved innovation and technology, developing cold chain to avoid wastage, improved transportation & storage facilities, development of food processing and packaging industries, and advancement in the poultry sector.

Renewable energy

Issues: Key solution & not as alternate source, issues: conventional dependence, high price of renewables, and inaccessibility.

Solutions: Huge potential for solar (Tropic of Cancer), decentralization of energy source (local solar plant at the village), incentivized with single window clearance, free stamp duty, & incentivized solar pumps.

Conclusion

Policy

- **Institutional and policy squeeze**
- National Action Plans that link economic growth to **intersectoral planning, institutional backing** from PM-Office, Lok Sabha and Rajya Sabha
- **Multipurpose and integrated infrastructure** planning of water, energy, and food sector
- **Stakeholders'** involvement

Water

- **Autonomy & ownership** of water resources
- **Increase in forest cover:** GW recharge, dec soil erosion, maintain local area temp, dec evaporation
- **Development** of Check dams, watershed, biomass production, soil moisture, etc. lead to improved agri production

Energy

- **Renewable sources of energy:** Solar, biomass, etc.
- **Biogas plant** construction as the area has a large cattle population, based on availability of land and income, remain used as fertilizers
- Immense scope of **solar** and sun availability is high

Food

- **Optimal cropping** system that are better suited for this **agro-climatic zone**
- Less water intensive that generate more income like oilseed, Babul, Tendu, Ber, Chironji, Khatha, etc.
- **Awareness** about pesticide, insecticides, fertilisers, traditional seeds, to promotes **organic food** and to safeguard flora and fauna
- **Training** on crop yield, nutritional value, carbon footprint, soil fertility, resource efficiency

The research highlights the current situation, important information, data, facts, issues, and challenges pertaining to water-energy-food resources by studying **five-year plans** and other related literature. The literature study reveals that those **resources are not managed efficiently**, and it is leading to a crisis at the local levels. It is leading to the **insecurity** of water, energy, and food resources. These **sectors are intrinsically linked** and cannot be studied in **siloes** as they have a **strong relationship and effect** on each other. Integrated governance approaches including WEF Nexus are called for as expeditious means to pursue national to local objectives. Ministries and Departments will continue to operate sectorally but with institutional squeeze from policy and operational spheres, they can become more attentive to other **sectoral priorities** that will in turn **increase responsiveness** and enhance broader societal and environmental outcomes in India and globally.

Thank You

Global South Academic Conclave on WASH and Climate 2025

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